SEATTLE PUBLIC UTILITIES
Drainage Design Options for street right of ways.

Numerous ecosystem-based functional stormwater quantity and quality design alternatives are possible within the street ROW. Several of these options are presented below, in order of increasing capability to convey stormwater.
Options include the following:

A. Tree Retention
B. Tree Pit Enhancement.
C. Infiltration and Conveyance Trench
D. Linear Bioretention
E. Subsurface Linear Bioretention
F. Porous Pavement
G. Interconnected Vegetated Swales
H. Rock and Vegetation Systems

These surface conveyance systems can provide a number of the City's drainage, pedestrian and vegetation goals. However, not all systems can provide all of these benefits, so goals for the system must be clearly identified. For example, detention and water quality goals sometimes compete for the same water storage volume, so one of these goals must be prioritized. The nature of the ecosystem-based designs, however, offers some of the goals described bellow as an inherent benefit.

- Drainage Goals:
  - Convey 25-yr, 24-hr design storm
  - Reduce peak flows by meeting detention requirements/goals for projects.
    - ◊ Creek goals = in some jurisdictions this is the 1-year storm event held to predeveloped conditions, or 2-year storm event held to ½ predeveloped conditions.
    - ◊ City of Seattle detention goals = (2yr/25yr/100yr storms) to pre-defined release rate. Note: Multiple stage, controlled outlet orifices are difficult with these systems and may not be achievable in some of the designs.
  - Meet water quality requirements/goals = the 6-month storm event, or 90% of the average annual runoff volume.
- Pedestrian and emergency vehicle safety and access:
  - Provide porous concrete sidewalks, when appropriate.
  - Allow safe pedestrian access from car to sidewalk.
  - Allow fire truck and ambulance access through neighborhood.
- Bio-Logical goals:
  - Optimize use of space so trees can be planted.
  - Promote healthy tree and vegetation root growth.
  - Reduce competition between roots and pipes.
  - Use right-of-way area as public open space amenity.
- Maintenance goals:
  - Inspire neighborhood participation.
  - Provide easy access to "hard" infrastructure (inlets, CBs, pipes).
- Financial goal:
  - Lower or neutral in cost than traditional piped system designs.

A. Retain Trees

Design around existing trees to maintain the interception and evapotranspiration capabilities on the site.

B. Tree Pit enhancement
ex. Rainier Ave (5/15/2001)

Widen tree pit area where problems with ponding on sidewalk exist. Larger exposed area allows more area for infiltration, reducing water problems and providing water for vegetation.

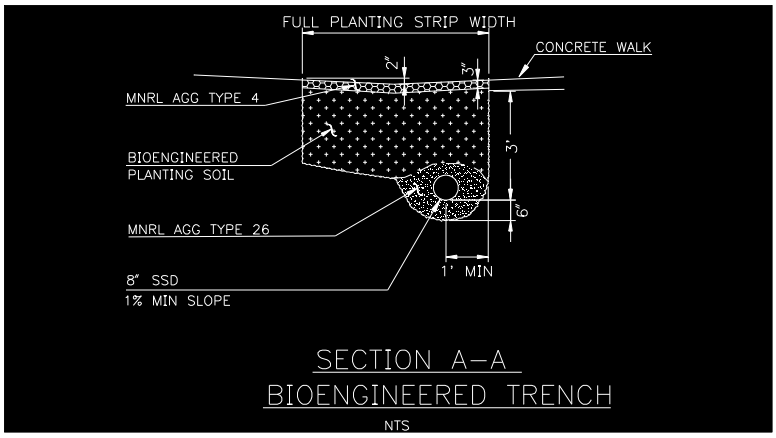
Goal: Reduce ponding on walkway. Provide more water to trees.
Drainage Area: Adjacent sidewalk.
Applicable Site: Sidewalk areas with ponding problems.

C. Infiltration and Conveyance Trench
ex. 30th Ave NE (9/30/00)

Traditional infiltration trench spaced in planting strip in an untraditional way. Meandering the infiltration trench within the within planting strip provides space for tree planting, and a more aesthetic look to the exposed gravel portion of the trench. System can be designed to encourage or discourage infiltration.

Goal: Provide detention and/or water quality treatment. Sizing and rock type will vary according to goal.
Dimensions, rock trench: 2'-3' wide x 2'-3' depth.
Drainage Area: Adjacent sidewalk or sidewalk plus road drainage.
Applicable Sites: Planting strips with width ≥ 8-feet. Linear slope 1% to 6%?

D. Linear Bioretention Systems



Planting strip design using amended soil that promotes both vegetative health and runoff infiltration. Run-off filters through the soil and moves downgradient along the length of the strip where it is then conveyed through an exit pipe to the main stormwater system. The soil mixes for the BPS are still in the experimental stage. The mixes are predominantly a sandy soil mix with enough planting soils and compost to sustain vegetation growth. A gravel flow dispersion area should be included down the length of the impervious contributing area. System can be designed to encourage or discourage infiltration.

Goal: Provide detention and/or water quality treatment. Sizing varies according to goal. All soil mixes used provide water quality treatment as added benefit, even when sizing for detention.
Dimensions: approx. 4'-5' wide x 2'-3' soil depth x 1-6" ponded water depth.
Drainage Area: Adjacent sidewalk or sidewalk plus road drainage.
Applicable Sites: Planting strips with width ≥ 4-feet. Linear slope 1% to 6%?. Sites exceeding approximately 4% slope will require check dams. Larger drainage areas combined with steeper will likely require surface treatment with gravel instead of mulch.

D-1: LBS without curb and gutter ex. NW 87th St (10/01)

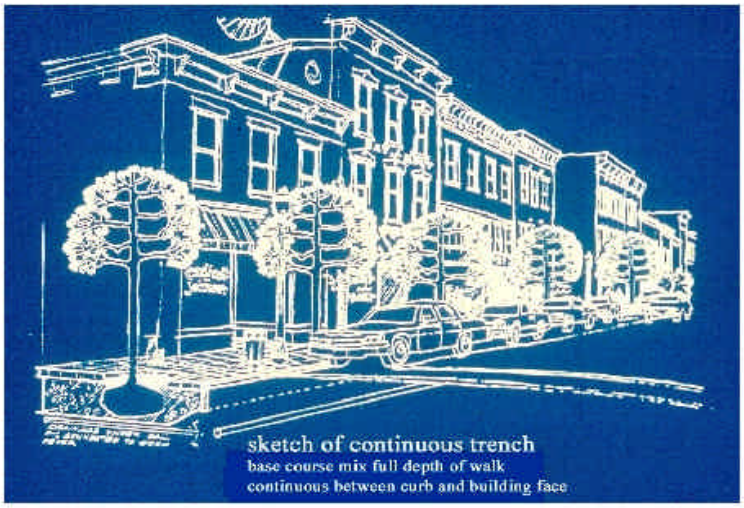
Flow from both the sidewalk and roadway can enter the system as sheet flow. Subsurface flow exits the system through a slotted pipe connected to the ditch and culvert system.

D-2: LBS with curb and gutter ex. NE Blakeley (12/13/00)

The Blakeley pilot project provides detention and conveyance of flows from the adjacent sidewalk. In order to treat flows from an adjacent road, curb openings are included in the system's design.

E: Subsurface Linear Bioretention System (S-LBS)
No pilot projects in Seattle at this time

The BPS design can also be used in the ultra-urban environment under pedestrian walkways. This can be achieved by several methods: concrete tree box with or without interconnection to other tree boxes, continuous concrete trench boxes with grate top, or structural soil mixes (an appropriate structural soil mix for Seattle has not yet been selected). Flow enters the system through curb openings or inlet and catch basin.



Using space under the sidewalk for root growth is the only place for trees to find adequate soil.

F: Porous Pavement
Sidewalk NW 145th from Dayton Ave N to Linden Ave N

One method of addressing stormwater flows is to reduce the amount of surface flow generated, while encouraging the amount of infiltration. Porous pavement allows water to flow through the pavement into the pavement's subbase. The subbase can be used to provide detention while water infiltrates into native soil, or is discharged through an outlet pipe.

Goal: Provide subsurface detention and/or water quality treatment.
Dimensions: Full pavement surface area.
Drainage Area: Adjacent street, sidewalk and rooftop areas.
Applicable Sites: Linear slope 0% to 5%.

G: Interconnected Vegetated Swales
ex. SEA street (2nd Ave NW, from NW 117th to NW 120th St) (1/01)

Interconnected vegetated swales are a modification of the standard bioswale. The simplest version of an interconnected swale system is a gradually sloped vegetated ditch connected with culverts under driveways, used to achieve water quality improvement. Detention in a vegetated swale system can store volumes generated by the adjacent street and rooftop areas. Additional area contributing to the site can be conveyed through the system, but a standard street ROW will not have the capacity to achieve detention for offsite flows. Detention swales can be created in several ways, including the following:

G-1: Undersized culverts to connect the swales so that flow is forced to backup during large storm events. This option detains the 25-year storm event for a street improvement project with a large contributing drainage area.

G-2: Flow control structures to back flow into the detention swales. The SEAStreet pilot project is an example of this type of system.

Goal: Provide detention and/or water quality treatment.

Dimensions: Swale sizing varies according to goal, drainage area, and site slope. Minimum top swale width is about 9-feet. Minimum length of swale area is 200-feet. Maximum surface ponding depth of 1-foot and side slopes of 3H:1V are recommended for safety.

Drainage Area: Detention goals can be met for approx. 2-acres. Conveyance capacity of approximately 10?-acres. Applicable Sites: Pervious ROW width ≥ 11-feet. Linear slope 2% to 6%. Sites exceeding approximately 4% slope will require check dams and/or surface treatment with gravel instead of mulch.

H: Rock and Vegetation Systems
ex. Viewlands Cascade

Stormwater flow can reach velocities that are too high for standard vegetated practices. Velocities become high when there are large drainage areas confined to proportionately small conveyance channels. In order to convey these flows while still providing a vegetated surface conveyance, the channel area is armored with rocks or geotextile fabric. Additionally numerous check dams are needed down the length of the project.

Goal: Provide detention and/or water quality treatment. Due to the large drainage areas of these systems, achieving the full detention or water quality treatment volume of a given storm event is not possible without subsurface detention pipes. However, detention volumes and water quality treatment for a portion of the contributing drainage area can be achieved.
Dimensions: Cells are generally designed to maximize the use of space available. Minimum top width is about 10-feet. Minimum length of swale area is 200-feet. Maximum surface ponding depth of 1-foot is recommended.
Drainage Area: Approximately 10 to 35-acres.
Applicable Sites: Pervious ROW width ≥ 15-feet. Linear slope 2% to 10%.